Meiosis

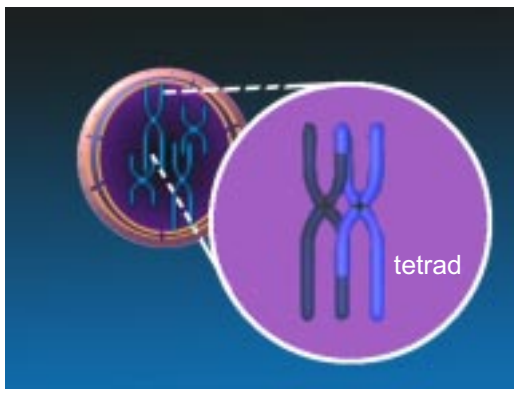
All of our cells (except our gametes, sperm or eggs) contain **pairs of chromosomes**, called **homologues** – one homologue of each pair came from our mother (maternal homologue) and one homologue from our father (paternal homologue). **Mitosis** creates identical copies of every one of a cell's chromosomes in two daughter cells. But **Meiosis** is different – it splits up the homologous pairs creating cells with only half of the number of chromosomes. These cells are the gametes. Thus, Meiosis occurs only in specialized cells involved in the production of gametes. The graphics show meiosis in animal cells.

Meiosis 1

There are two stages of meiosis, 1 and 2. During Meiosis 1, a cell divides to form daughter cells with half the number of chromosomes of the original cell. Before Meiosis 1 begins, the cell's DNA duplicates, making two copies of each chromosome (these will become the sister chromatids).

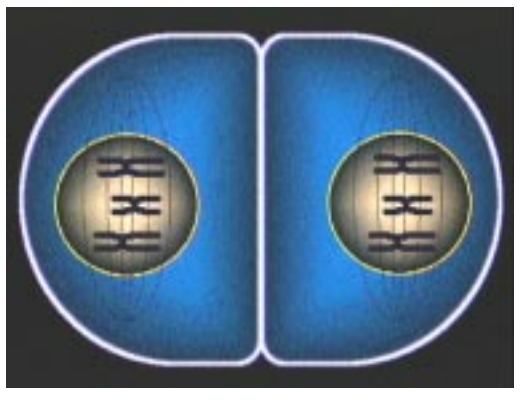
Meiosis 2

During this second stage of meiosis, the chromosomes in each haploid daughter cell divide, separating the two sister chromatids. The result of Meiosis 2 is four haploid (1n) daughter cells.



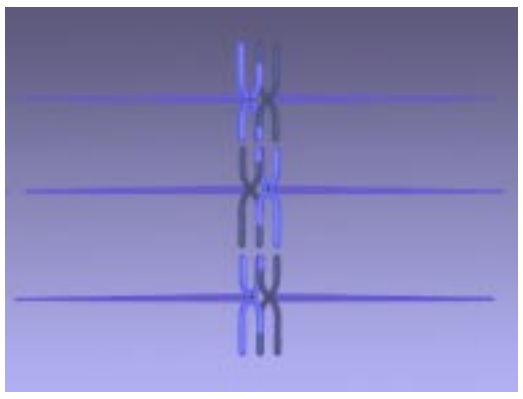
Prophase 1

The two identical sister chromatid copies condense, linked together at a centrosome. Then synapsis occurs, where homologous chromosomes come together as tetrads. At this point there can be an exchange of segments across homologous chromosomes – called **crossing over**.



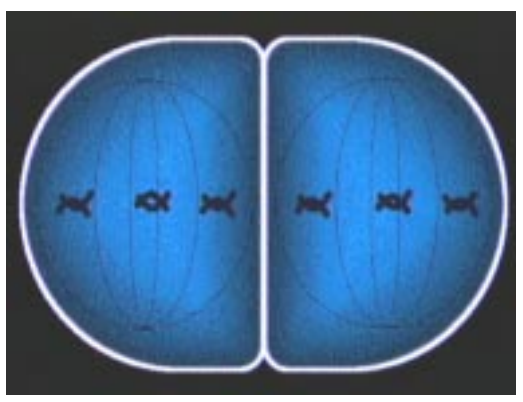
Prophase 2

The spindle apparatus is generated and elongates out from each pole. The chromosomes in each daughter cell migrate towards the metaphase 2 plate.



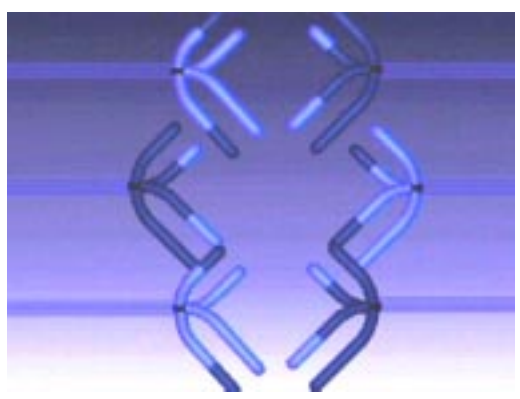
Metaphase 1

The chromosome tetrads line up along the metaphase plate.



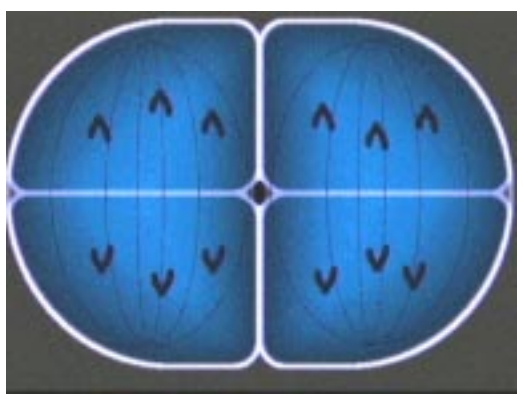
Metaphase 2

The chromosomes align along the metaphase 2 plate.



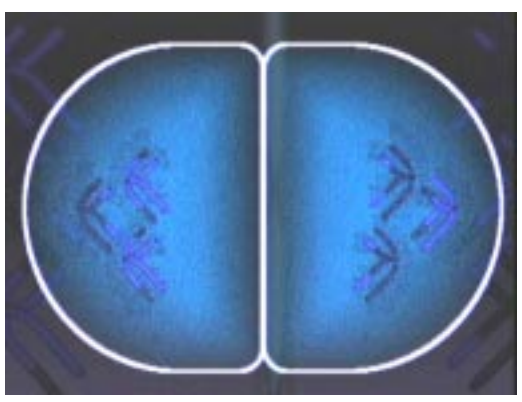
Anaphase 1

Each tetrad splits, and homologues now move toward the poles. Whether the paternal homologue, or the maternal homologue will go toward one pole or the other is a completely random process. This is **Independent Assortment**.



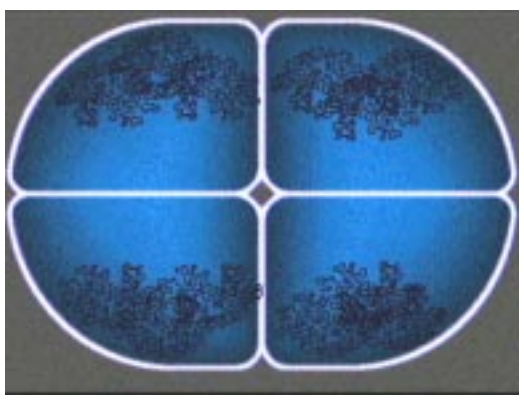
Anaphase 2

Each sister chromatid is pulled to opposite poles of the spindle. Each chromatid is now an individual chromosome. Cytokinesis is already beginning by the end of anaphase 2.



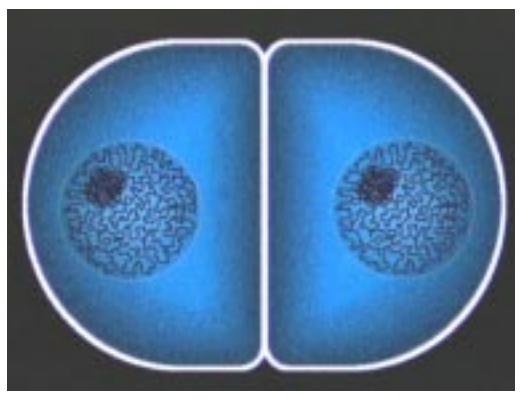
Telophase 1

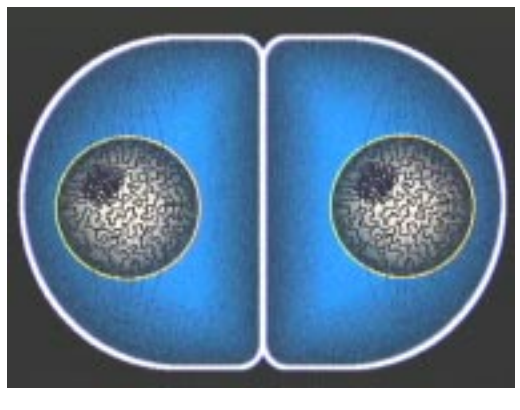
The homologues reach the opposite poles. Each end of the cell now has a set of 1/2 of the original cell's chromosomes (assorted randomly [paternal or maternal] and somewhat altered because of crossing over).



Telophase 2

The chromatids reach opposite poles and relax into chromatin fibers. Nuclei begin to form at each pole, with the nuclear envelope regenerating.

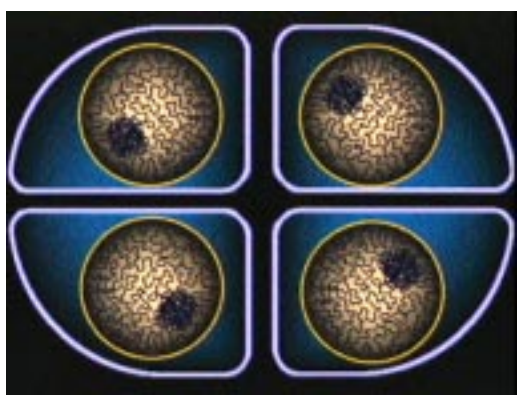




Cytokinesis 1

The division of the cytoplasm completes Meiosis 1. In animal cells, a cleavage furrow will form on the metaphase plate. In plant cells, a cell plate will form on the metaphase plate and a new cell wall will be created.

In Meiosis 1, each daughter cell has 1/2 of the original cell's chromosomes (although they are pairs of sister chromatids), so they are haploid (1n). Depending on the species of organism, there may be a delay before Meiosis 2 begins. Replication of DNA does not occur again after Meiosis 1.



Sperm (l) and egg (r) of a sea urchin

Cytokinesis 2

Division of the cytoplasm and formation of the nucleus completes Meiosis 2. The entire process of meiosis has now created four haploid daughter cells (1n) from one diploid (2n) original cell. These four cells go on to become gametes – eggs or sperm – or they become cells associated with gametes (such as the polar bodies in mammals).

These gametes will then combine with other gametes, producing a zygote (2n) with a full complement of chromosomes (both sets of paternal and maternal homologues) that can develop into a new individual (2n).